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EVALUATION OF PROPOSED METHOD OF ESTIMATING WORK OUTPUT OF ARMY--ETC(U)
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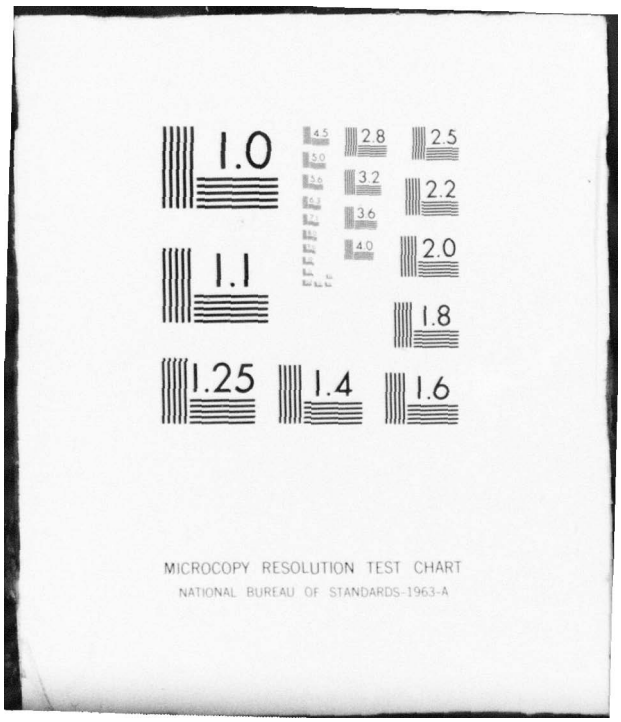
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RESEARCH MEMORANDUM 61-14

EVALUATION OF PROPOSED METHOD OF ESTIMATING WORK OUTPUT OF ARMY PERSONNEL FOR USE IN OPTIMAL REGIONS ALLOCATIONS

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(6) EVALUATION OF PROPOSED METHOD OF ESTIMATING WORK OUTPUT OF ARMY PERSONNEL FOR USE IN OPTIMAL REGIONS ALLOCATION

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EVALUATION OF PROPOSED METHOD OF ESTIMATING WORK OUTPUT OF ARMY PERSONNEL FOR USE IN OPTIMAL REGIONS ALLOCATION

STATEMENT OF THE PROBLEM

The optimal regions method of personnel classification is currently under study to determine if the method can be developed for operational use in solving Army personnel allocation problems. The optimal regions method is based on the concept of maximizing the estimated output of personnel entering the Army. At the time of classification, future output can be predicted by combinations of tests called aptitude areas. Each aptitude area score is an estimate of future output associated with a particular occupation (MOS group). The sum of aptitude area scores for the incumbents of each occupation represents the estimated group output for each occupation. Summing over all occupations and subjects produces the estimated total output for all occupations combined.

The above concept of optimal allocation assumed that all personnel remain in a single occupation during the terms of their military service, thus spending the same amount of time in a given MOS. Transfers of personnel from one occupation to another, however, might result in a biased estimate of output within any given occupation. The present study evaluated a proposed method for equating estimates of work output in terms of differences in time spent by individuals in a given MOS group.

DEVELOPMENT OF THE PROPOSED STATISTICAL METHOD

The output as estimated by tests (X) assumes that all men in a given occupation spend the same amount of time in it. If the amount of time in an occupation differs from man to man, then the output in a given occupation must be weighted by the proportion of time (P) each man serves in that occupation. Thus, the estimated output for the time one man serves in one occupation is PX. The sum of the estimated outputs of all men who work in the occupation is ΣPX.

The above estimate of output in an occupation, however, would require an excessive amount of computation. A possible short-cut involves the computation of the average percent of time ($\bar{P}$) served by incumbents in an occupation. This average percent of time for the occupation could then be used in a short-cut formula to estimate the absolute output for the occupation: $\Sigma\bar{P}X$.

The extent of error incurred by using the average percent of time in an occupation in place of the individual percents is estimated by computing the difference (D) between the two estimates, using the formula:

(1) $$D = \Sigma PX - \Sigma\bar{P}X$$

Obviously, $\bar{P}$ could be substituted for each P if the above difference is not significantly different from zero. However, since there is no known standard error formula for this difference, the statistic cannot be evaluated directly in probability terms. The difference (D) may, however, be expressed as a linear function of a correlation coefficient. The correlation statistic can then be evaluated as usual in probability terms.

The derivation of the correlation coefficient as a linear function of the difference is developed below. Equation (1) can be written as follows, when N is the number of cases in the designated occupation under study.

$$(2) \qquad D = \Sigma PX - \sum(\frac{\Sigma P}{N})X$$

Equation (2) can be rearranged

$$(3) \qquad D = \Sigma PX - \frac{\Sigma P}{N}(\Sigma X)$$

Multiply both sides of equation (3) by N to get

$$(4) \qquad ND = N\,\Sigma PX - \Sigma P\,\Sigma X$$

The above equation is algebraically equal to N times the sum of the cross products of variables P and X in deviation form.

$$(5) \qquad ND = N\,\Sigma px$$

$$(6) \qquad D = \Sigma px$$

The sum in (6) can be written: $\Sigma px = N\, r_{px}\, s_p s_x$, consequently (6) can be rewritten:

$$(7) \qquad D = N\, r_{px} s_p s_x$$

It is apparent from equation (7) that if r_{px} is not significantly different from zero for any given occupation, then D is not significantly greater than zero. Thus, the effect of substituting $\bar{P}$ for the P of each individual in an occupation can be tested by determining the significance of r_{px} for each occupation. If the r_{px} for all occupations are proved to be essentially zero, then the average or expected value of the percent of time in the occupation ($\bar{p}$) could be used in lieu of the calculation of each individual percent (P) for each man in each occupation.

PROCEDURE

The technique described was applied to data available on a sample of enlisted men. Soldiers who had served in the Army from 21 to 24 months during the Korean War period and after (1952 to 1955) comprised the population. A sample of 710 usable cases was selected for study after rejecting cases with incomplete records, early discharges, confinements and extended hospitalizations.

The percent of time each man had served in any occupation, and the aptitude area scores, were obtained from personnel qualification records. Coefficients of correlation were then obtained between the percent of time served in each occupation and scores on the aptitude area used to select personnel for that occupation. Correlation coefficients were computed for the total sample and by separate occupational groups into which the men were initially classified for training. Each coefficient was then evaluated to determine whether it was significantly different from zero. Any correlation coefficients significantly different from zero were to be taken as indicating the possibility of introducing error by using $\Sigma\overline{P}$ in lieu of ΣP in the proposed application of the optimal regions allocation method to Army classification problems.

Three tests of the current Army Classification Battery had not been made operational at the time this sample was tested: the Classification Inventory, the General Information Test, and the Electronics Information Test. Results for three aptitude areas were therefore estimated by multiple regression as described in Appendix A. The estimated scores are indicated by primes (IN', AE', EL') in Table 1.

RESULTS

Significant differences between the obtained correlation coefficient and a correlation of zero were obtained for three occupations studied (Artillery, Engineer, Armor; Electronics; and Clerical). In the case of the Clerical occupation, the result was confirmed when a homogeneous group of clerks was studied.

The occurrence of significant correlation (both before and after classification had taken place) indicated that errors of allocation might occur if $\Sigma\overline{P}$ were to be substituted for ΣP in an application of optimal regions method to Army classification problems. Although the obtained coefficients were not large by some standards, further refinement of the occupational structure of the Army classification system might tend to increase them in the future.

The problem of developing a measure of work output suitable for use in applying a mathematical classification system to Army personnel problems remains to be solved. Multiple regression techniques or other means of equating for time in occupation have been treated on a theoretical level, but not yet tested empirically. (Graham, 1960).

Table 1

SIGNIFICANCE OF OBTAINED COEFFICIENTS OF CORRELATION BETWEEN TIME IN A GIVEN OCCUPATIONAL AREA AND THE APPROPRIATE APTITUDE AREA SCORE[a]

Aptitude Area Score	Occupational Area	Correlations Coefficients: Total Sample r_{xp}	Total Sample N	MOS Group r_{xp}	MOS Group N
IN'[b]	Infantry	-.03	710	.03	250
AE'[b]	Artillery, Armor, Engineer	.19*	710	.04	146
EL'[b]	Electronics and Electrical Maintenance	.09*	710	.12	61
GM	Precision Maintenance and Military Crafts	.04	710	.08	53
MM	Motor Maintenance	.04	710	.13	47
CL	Clerical	.23*	710	-.32*	55
GT	General Technical	.07	710	-.10	98

[a] Evaluation of $D = \Sigma PX - \overline{\Sigma PX}$ as a Function of r_{xp}.

[b] (') indicates estimated scores.

* Significantly different from zero at the .01 level.

SUMMARY

This report covers the development and evaluation of a proposed technique for equating work output measures for differences in time spent in each Army occupation. The proposal involved the theory that percent of time spent in each occupation could be used to weight each estimated output value (aptitude area score) in order to obtain an index of the absolute output of each subject. A short-cut method was sought to avoid the great amount of calculation required in practical application. The proposed short-cut was to substitute the expected percent of time in an occupation (mean percent of time for the occupational group studied) for the percent of time spent by each individual.

The proposed substitution was evaluated in probability terms to determine if error introduced by the short-cut would significantly influence the effectiveness of a mathematical classification procedure in any practical application. A statistical technique was developed to make this test, and the evaluation was performed on data from a sample of 710 enlisted men who had served during the Korean War period. The results indicated that the proposed substitution of the expected percent of time for the actual percent of time in occupation would produce a significant difference in the estimate. It was concluded that use of the proposed substitution would be hazzardous in view of the likelihood of significant errors being introduced into an operational mathematical allocation system.

REFERENCE

Graham, Warren R. A theoretical classification index: A criterion for "Value" problems in personnel research. Paper read at Convention of American Psychological Association, Chicage, Ill., 1960.

APPENDIX A

Three new Army Classification Battery tests have been made operational since the present sample was tested; consequently, the scores for these tests and the aptitude area scores computed from them were not available. The missing Aptitude Areas were (IN) Infantry, (AE) Artillery, Armor, Engineer, and (EL) Electronic. In order to provide results that would reflect current testing procedures, the missing test scores were estimated by multiple regression from the available tests, and the new aptitude area scores were computed using the estimated ACB test scores.

To assure that the predicted scores were based on stable regression weights, the obtained regression weights from one sample of 540 were applied to data from a second sample of 1500 as a cross-validation:

ACB Tests Correlated	Validity (N = 540)	Cross-Validity (N = 1,500)
$r_{CI,CI'}$	.64	.60
$r_{GIT,GIT'}$	.83	.80
$r_{ELI,ELI'}$	.82	.79

The primed scores indicate estimated scores based on multiple regression.

Estimates of the missing aptitude area scores were calculated by using the above predicted scores of the ACB tests. Correlation coefficients between the actual aptitude area scores and the estimated aptitude area scores were as follows:

$$r_{IN,IN'} = .80$$

$$r_{AE,AE'} = .89$$

$$r_{EL,EL'} = .84$$

The estimated aptitude area scores are primed. All calculations were made on coefficients that were corrected for restriction in range.

The correlation coefficients between obtained and estimated aptitude area scores approached their respective reliability coefficients. The scores were therefore considered to be equivalent.